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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

<p>(51) International Patent Classification <sup>6</sup> : <b>B29C</b></p>		<p>(11) International Publication Number: <b>WO 96/29186</b></p>
		<p>(43) International Publication Date: <b>26 September 1996 (26.09.96)</b></p>
<p>(21) International Application Number: <b>PCT/CA96/00156</b></p>		
<p>(22) International Filing Date: <b>14 March 1996 (14.03.96)</b></p>		
<p>(30) Priority Data: <b>2,144,719</b> <b>15 March 1995 (15.03.95)</b> <b>CA</b></p>		
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<p>(81) Designated States: <b>AU, CN, JP, MX, NO, NZ, US, European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).</b></p>		
<p><b>Published</b> <i>Without international search report and to be republished upon receipt of that report.</i></p>		

(54) Title: **EXTRUSION METHOD AND APPARATUS THEREFOR**

(57) Abstract

A method of simultaneously extruding at least two thermoplastic profiles utilizing a single extruder outputting a flow of heated thermoplastic material comprising dividing the output flow from the extruder into at least two streams, delivering each of said streams through a profile forming die to convert the stream to a profiled stream, individually pulling each profiled stream emerging from its profile forming die through a calibrating unit for that profile, and adjusting the speed of pull of each profiled stream so that the take away of the profiled stream from its respective profile forming die matches the rate at which it emerges therefrom. The invention also includes apparatus for carrying out the method.

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## EXTRUSION METHOD AND APPARATUS THEREFOR

### FIELD OF THE INVENTION

5 This invention relates to an extrusion method and apparatus therefor.

### BACKGROUND OF THE INVENTION

10 Extrusion lines for producing extruded thermoplastic products formed by forcing heated thermoplastic material through a die and then calibrating same to produce a product stream having a desired cross sectional shape and size or profile require the employment of equipment requiring a very substantial outlay of capital.

15 Each extrusion line requires the use of an extruding machine or extruder to force the heated plastic through the requisite die, a series of vacuum operated profile sizers or calibrators for finally forming and cooling the product stream so that it has precisely the profile desired, a puller mechanism to pull the product stream through the calibrators, a cutoff or saw mechanism to cut off appropriate lengths of the product, and a receiving table to receive the cut product lengths.

20 Each such extruder line occupies a substantial area of plant floor space and requires its own utilities and operator.

25 Extrusion manufactures usually extrude products having a range of sizes from small profile products having a small volume of material per foot, to large profile products having a substantial volume of material per foot.

30 The smaller profile products are conventionally produced on extrusion lines having smaller capacity extruders while the large profile products require extrusion lines with extruders of much higher capacity.

5 The smaller capacity extruders which having a somewhat lower cost than the high capacity extruders are not capable of delivering a sufficient volume of heated material at a sufficient pressure to render them practical to produce the large profiles. On the other hand, it is not practical to take advantage of the capacity of the large capacity extruders to produce the smaller profiles since if they were operated at capacity they would have to deliver a product stream at such high velocity that it would be impractical to properly calibrate same and obtain a precision profile.

10 As a result, at present, the production of small and large extrusion profiles has required a proliferation of extrusion lines occupying a large plant floor area with each line requiring its own operator and service utilities such as electrical power and cooling water lines.

15 BRIEF DESCRIPTION OF THE INVENTION

20 The present invention resides in a method and apparatus whereby a high capacity extruder can be operated efficiently to not only produce precision small profiles as well as precision large profiles but will produce such small profiles at an output rate substantially matching the output of at least two separate small capacity extruder lines thereby reducing or eliminating the need of multiple extrusion lines to provide important cost savings in plant space and utility and manpower costs.

25 More particularly, the invention resides in dividing the output flow of an extruder into separate stream flows, delivering each stream through a profile forming die to produce a profiled stream, and individually pulling each profiled stream through its associated calibrators at a speed so that the profiled stream emerging or exiting from its profile forming die is pulled away therefrom at the same speed with which it emerges.

**BRIEF DESCRIPTION OF THE DRAWINGS**

Figure 1 is a perspective view of the front portion of an extrusion line embodying the invention;

5

Figure 2 is a perspective view of the end portion of the extrusion line of Figure 1;

10 Figure 3 is a broken away perspective view illustrating a flow divider assembly attached to the output of the extruder;

Figure 4 is a horizontal cross-sectional view of the flow divider of Figure 3 and showing it feeding separate die assemblies;

15 Figure 5 is a front elevational view of typical profile forming dies for forming typical profiled products which can be extruded simultaneously according to the invention;

20 Figure 6 a broken away perspective view illustrating the profiled product streams being pulled through the system by independent pullers;

Figure 7 is a schematic perspective view illustrating the independent drive of the separate pullers;

25 Figure 8 is a broken away perspective view illustrating the independent saws for cutting off the desired lengths of the separate simultaneously produced profiled product streams;

30 Figure 9 is a perspective view of an alternative form of flow divider having provision for selectively closing off one or other of the divergent branch leg portions of the flow dividing Y passage;

Figure 10 is a diagrammatic horizontal cross sectional view showing the shutter member in its middle position with both divergent branches of the Y passage open;

5 Figure 11 is a view similar to Figure 10 but showing the shutter bar moved to block off the right hand branch of the Y passage while the left hand branch is fully open;

10 Figure 12 is a view similar to Figure 11 but showing the shutter bar moved to block off the left hand branch of the Y passage while the right hand branch is fully open;

15 Figure 13 is a broken away perspective view of the use of the parallel pullers pulling a large profiled product stream through the system when the flow divider is removed and the extruder feeds a single die of a large profile requiring the extruder to be operated at full capacity.

20 Extruders for extruding heated thermoplastic material through a profile forming die to produce a thermoplastic product stream having a predetermined cross sectional configuration or profile are available with different capacities. The capacity of an extruder is measured in terms of the quantity of thermoplastic material it can deliver at extrusion pressures per unit of time.

25 Extruders normally, in addition to heating the thermoplastic material to an appropriate temperature normally of the order of 170 to 180° C for flowing through the extrusion die, employ a feed screw to deliver the heated material to the die under extruding pressure and at a feed rate dependent 30 upon the speed of rotation of the feed screw operated by a variable speed drive.

For an example, extruders capable of delivering from about 200 to 300 kilograms or from about 500 to 700 pounds of heated thermoplastic

material per hour and at an extrusion pressure of the order of about 3,000 to 5,000 pounds per square inch would be considered in the higher capacity extruder range for profiles.

5 If an extruder with a capacity of 600 pounds per hour were used at capacity to produce a profiled product having a weight of one pound per foot, then the product would be produced in a stream flow of 10 feet per minute. A profiled product having a weight of one-half pound per foot would be produced at a stream flow of 20 feet per minute.

10

The product stream exiting from the profile die is relatively soft and does not have the profile precision required in the final product being usually about 1 to 1 1/2% bigger than the final profile. This rough profile stream then is required to be pulled through sizers or calibrators having the appropriate 15 internal configurations corresponding to the profile die where the stream is subjected to vacuum to pull same forcefully against the calibrator's walls while at the same time it is subject to the cooling effect of water being circulated within the calibrators so that the product exiting therefrom has a precise and accurate profile.

20

If the product stream from the forming die exits or emerges too fast because the extruder is operating at or near capacity, the speed at which the product stream must be pulled through the calibrators will be too high to provide the requisite cooling and sizing so that the product stream exiting the 25 calibrators will not have the requisite accuracy. It is then necessary to slow down the feed of the extruder so that it is operated at a reduced capacity and its value as a high capacity machine is lost.

30

In attempting to solve the problem and enable the extruder to be used at or near full capacity for extrusion products with smaller profiles, the output flow of the extruder was split into separate equal flow passages and the material in these passages forced through forming dies of the same configuration to produce two product streams of the same profile. However, when these two streams were pulled through their calibrators, the products

As will be understood, the calibrators are water cooled to cool the profiled product stream as it is calibrated and this cooling is provided by waterlines 16 circulating cooling water therethrough.

5 The calibrated product stream emerging from calibrator 12c which started out as a somewhat roughly profiled product stream 10 issuing from die assembly 5 is designated as calibrated product stream 10c which now has a precise profile. Similarly, the calibrated product stream issuing from calibrator 13c is designated as calibrated product stream 11c.

10 The product streams 10c and 11c are pulled through the calibrators by individual pullers 17 and 18 respectively.

As hereinafter more fully explained, the speeds of the pullers 17 and 15 18 are individually controlled to the precisely correct speeds so that puller 17 operates to pull product stream 10c at precisely the right speed so that the product stream 10 is pulled away from its die assembly 5 at precisely the rate it emerges therefrom. Similarly the speed of puller 18 is set so that it pulls the 20 profiled product stream 11c at precisely the right speed so that the product stream 11 is pulled away from its die assembly 6 at the speed it emerges therefrom.

25 The pullers 17 and 18 which, as will be understood, are capable of exerting high pulling forces, eg. providing a torque of the order of 50,000 to 60,000 foot lbs., deliver the profiled product streams 10c and 11c to a saw station generally designated at 19 where a pair of saws 20 and 21 cut off the proper lengths of the profiled product streams 10c and 11c after they have been delivered to a dumping table station 22.

30 With reference to Figures 3 and 4, the flow divider unit 4 has a barrel portion 23 provided with a clamping flange 24 having slots 25 to receive bolts 26 projecting from the nozzle 3 of the extruder 1. Nuts 27 applied over washers 28 engaging the bolts 26 clamp the unit 4 to the face of the nozzle 3.

5 A flange 29 is formed at the forward end of the barrel portion 23. The flow divider 4 is bored to provide a Y passage formation generally designated at 30.

10 The leg portion 31 of the Y formation is arranged to register with the discharge outlet 32 of the extruder nozzle 3 to receive the heated thermoplastic material delivered by the feed screw 33.

15 The divergent branch or leg passages 34 of the Y passage formation are preferably equal in diameter and of the order of half the diameter of the leg portion 31 whereby material forced under pressure out of the discharge outlet 32 of the extruder is directed to divide equally between the two divergent passages 34.

20 A converter block 35 fastened to the face of the flange 29 by bolts 36 is bored to provide outwardly flared passages 37 to register with the outlets of the divergent passages 34 to convert the divergent flow through these passages into parallel flow streams for delivery to the die assemblies 5 and 6 which include adaptor blocks 38 and 39 with feed passages 38' and 39' for inputting coextruding material and profile forming dies 40 and 41 for forming the profiled product streams 10 and 11 respectively.

25 Figure 5 illustrates the profile 42 formed by die 40 and profile 43 formed by die 41.

30 In the extrusion process the heated thermoplastic material is delivered out of the extruder orifice or outlet 32 and into the leg passage 31 of the Y passage formation under high pressure at a predetermined fixed rate.

35 This material flow is then divided between the divergent leg passages 34 which between them must accept all of the material moving through the passage 31. With the passages 34 being of equal diameter, the volume flow therethrough is basically equalized but may be effected to some extent by the differences in resistance in flow impediment offered by the dies 40 and 41.

substantially depending on the profiles of the streams. It is therefore necessary to provide separate reciprocal saw assemblies 71 and 72 for the two streams 10c and 11c.

5 The saw assemblies 71 and 72 are of the same constructions and, as illustrated in Figure 8, each comprises a reciprocal carriage 73 slidable on guides 74 and driven by a reciprocating ram 75.

10 The carriage 73 is provided with a product stream hold down clamp 76 which is arranged to move down into clamping position during the cutting operation.

15 The carriage 73 also carries a motor driven saw blade 77 which is moveable up and down into the cutting position by a ram 78.

20 It will be understood that when the requisite length of the profiled product stream has moved past the carriage 73 the ram 75 will move the carriage in the direction of the product stream flow at the rate of the product stream flow while the hold down clamp engages the product stream and the saw blade is swung into the sawing position to effect the cut off of the product stream. Thereafter the hold down clamp will be released and the carriage will be returned to its original position awaiting passage of a further requisite length of the profiled product stream to be fed thereby whereupon the sawing process is repeated.

25 With the thermoplastic flow division arrangement of Figure 4, if it is desired to change one of the profile forming dies 40 or 41, it would be necessary to shut down the extruder while the die and its corresponding calibrators are replaced unless the passage 34 thereto was blocked during this replacement in which case the extruder could be operated at a slower speed. that is, below capacity to feed the remaining die.

30 The flow divider 79 illustrated in Figures 9 to 12 provides for selectively closing off one of the branches of the divided flow when desired.

In this case, the flow divider is provided with a mounting flange 80, a body portion 81 having a transverse passage of square cross section 82 extending therethrough and a flange portion 83. A shutter bar or plunger 84 is slidably mounted in the transverse passage 82 and is operated by a threaded drive 85 actuated by a hand wheel 86.

With reference to Figures 10, 11 and 12, it will be seen that the flow divider is provided with a central passage 87 extending inwardly through the 10 mounting flange 80 to the transverse passage 82 to receive the heated thermoplastic material being delivered by the extruder 1.

The flange portion 83 is provided with divergent passages 88 diverging outwardly from the transverse passage 82 to the outer face of the 15 flange 89.

The shutter bar 84 is provided with central diverging passages 90 forming a truncated V passage formation which when the shutter bar is in its 20 central position connect the central passage 87 in the mounting flange portion to the divergent passages 88 in the front flange portion 83 to provide a Y passage formation, of which the passages 90 form the apex of the diverging passages.

The shutter bar 84 is also provided at the left hand side as viewed in 25 Figures 10 to 12 with a passage 91 which is angled inwardly from the rear of the shutter bar 92 to the front of the shutter bar 93.

A passage 94 corresponding to the passage 91 is arranged at the 30 right hand side of the shutter bar as viewed in Figures 10 to 12 and again this passage 94 is angled inwardly from the rear face 92 of the shutter bar 84 to the front face 93.

As shown in Figure 11, when the shutter bar is moved to the right, the passage 91 connects the central inlet passage 87 with the right hand passage 88 while blocking off any flow to the left hand passage 88.

5 As shown in Figure 12, when the shutter bar is moved to the left, passage 94 in the shutter connects the central inlet passage 87 to the left hand passage 88 while the right hand passage 88 is blocked off.

10 With this arrangement when the flow is not being divided as illustrated in Figures 11 and 12 and one of the passages 88 is shut off, flow takes place only in the one open passage 88 so that no material can go to the closed off passage 88 to be trapped therein and hardened which would necessitate the difficult task of cleaning out that passage before it could be used again.

15 The flow divider 79 is provided with a converter block 95 secured to the front flange 83 and provided with passages 96 registering with the outlets of passages 88 to convert divergent flow into parallel flow.

20 The extruder 1 is of course capable of extruding a single product having a large profile such as the product 97 illustrated in Figure 13 which requires a large volume of material per linear unit so that it takes the full output capacity of the extruder for its production.

25 In this case, the extruder would simply feed directly into the requisite profile forming die and its associated calibrators (not shown) as in the conventional extrusion line. In this case, as illustrated in Figure 10, the product stream 97 would be pulled by the combined pulling power of the pullers 17 and 18 driven in synchronism at the appropriate pulling speed as controlled from the control panel 49.

30 It will be appreciated that in principle the output of the extruder 1 could be divided into more than 2 stream flows each with its own extrusion die calibrators and pullers provided the extruder had the capacity to run same.

Also it will be appreciated that the divergent passage of the flow dividers, eg. the passages 34 of the flow divider unit 4 need not be of the same diameter since the pullers for each product line can be adjusted to a pulling speed to compensate for the different diameters so that the profile stream emerging from each die can be pulled away at the rate it emerges therefrom.

It will be understood that variations or modifications may be made in the various components at the various stations along the extrusion line without departing from the scope of the appended claims.

THE EMBODIMENTS OF THE INVENTION IN WHICH AN EXCLUSIVE PROPERTY OR PRIVILEGE IS CLAIMED ARE DEFINED AS FOLLOWS:

1. A method of simultaneously extruding at least two thermoplastic profiles utilizing a single extruder outputting a flow of heated thermoplastic material comprising dividing the output flow from the extruder into at least two streams, delivering each of said streams through a profile forming die to convert the stream to a profiled stream, individually pulling each profiled stream emerging from its profile forming die through a calibrating unit for that profile, and adjusting the speed of pull of each profiled stream so that the take away of the profiled stream from its respective profile forming die matches the rate at which it emerges therefrom.
2. A method as claimed in Claim 1 in which the output flow from the extruder is divided into two substantially equal streams.
3. A method as claimed in Claim 2 in which said two streams are delivered to dies having the same profile.
4. A method as claimed in Claim 2 in which said two streams are delivered to dies having different profiles.
5. A method as claimed in Claim 1 in which the output flow from the extruder is divided into at least two streams having different cross sections.
6. A method of simultaneously extruding at least two profiled thermoplastic products utilizing a single extruder outputting a flow of heated thermoplastic material and having a capacity to produce a single profiled thermoplastic profile product having a volume of material per linear unit at least substantially equal to the sum of the volumes of material per linear unit of said at least two profiled products, said method comprising dividing the output flow from the extruder into at least two streams, delivering each of said streams through a profile forming die to form same into a profiled stream, individually pulling each profiled stream through a calibration unit to calibrate

same, adjusting the speed of pull of each profiled stream so that the take away of that stream from its respective profile forming die matches the rate at which it emerges therefrom, and cutting off desired product lengths of each extruded and calibrated profiled stream.

5

7. A method as claimed in Claim 6 in which the output flow from the extruder is divided into two substantially equal streams.

10

8. A method as claimed in Claim 7 in which said two streams are delivered to profile forming dies having the same profile.

9. A method as claimed in Claim 7 in which said two streams are delivered to profile forming dies having different profiles.

15

10. A method as claimed in Claim 6 in which the output flow from the extruder is divided into at least two streams of different cross-section.

20

11. Apparatus for producing a plurality of profiles from a single extruder comprising a flow divider for attachment to the output of an extruder and having a plurality of passages to divide the extruder output flow into separate flow streams, a profile forming die mounted to intercept each of said separate flow streams to produce an emerging profiled product stream, calibration means for each emerging profiled product stream, individual puller means to pull each profiled product stream emerging from each of said profile forming dies through its respective calibration means to calibrate same, means to adjust the rate of pull of each individual puller means to pull its respective profiled product stream away from its respective profile forming die at the rate it emerges therefrom, and means to cut off desired lengths of each calibrated profiled product stream.

25

12. Apparatus as claimed in Claim 11 in which said flow divider means divides the output stream from the extruder into two separate flow streams.

13. Apparatus as claimed in Claim 12 in which said two streams have the same cross section.
14. Apparatus as claimed in Claim 13 in which each profile forming die 5 is the same.
15. Apparatus as claimed in Claims 11, 12 or 13 having means to selectively close off one of said separate flow streams.
- 10 16. Apparatus as claimed in Claims 11, 12 or 13 in which each of said puller means comprises a pair of horizontally extending endless belts carrying a series of transverse product engaging bars having a measure of compressibility, said pair of endless belts being arranged with one superimposed over the other with the opposing horizontal reaches thereof 15 being spaced to engage the profiled product stream therebetween to be gripped by the said bars thereof under compressive force, motor means driving said endless belts so that said opposing belt reaches thereof travel in the same direction and at the same speed, and means to control the speed of said motor means to control the speed of said opposing belt reaches.
- 20 17. Apparatus as claimed in Claim 16 having means to adjust the compressive force exerted by said endless belts on the product stream gripped between said opposing belt reaches.
- 25 18. Apparatus as claimed in Claims 11, 12 or 13 in which each of said puller means comprises a pair of horizontally extending endless belts carrying a series of transverse product engaging bars having a measure of compressibility, said pair of endless belts being arranged with one superimposed over the other with the opposing horizontal reaches thereof 30 being spaced to engage the profiled product stream therebetween to be gripped by the said bars thereof under compressive force, a separate motor driving each of said endless belts with said opposing belt reaches thereof travelling in the same pulling direction, said motors being synchronized so that said opposing belt reaches travel at precisely the same speed, and control

means for said motors to precisely control the speed of travel of said opposing belt reaches.

19. Apparatus for simultaneously producing two separate profiled extrusions from a single extruder; said apparatus comprising a flow divider for mounting to the extruder, said flow divider having a Y passage formation formed therethrough comprising a central inlet passage of a diameter to receive the column of output flow of heated thermoplastic material from the extruder and a pair of side-by-side output passages of smaller diameter than said inlet passage diverging laterally outwardly from said inlet passage, an adaptor for mounting to said flow divider having passages therethrough adapted to register with the ends of said diverging output passages and formed to provide spaced parallel output flow passages, a profile forming die mounted to register with each of said spaced parallel output flow passages, a calibration unit for each of said profile forming dies aligned therewith, a puller for pulling product through each of said calibration units, and means to control the speed of pulling of each of said pullers.
20. Apparatus as claimed in Claim 19 in which said divergent passages have the same diameter.
21. Apparatus as claimed in Claim 20 in which the diameters of said divergent passages are one-half the diameter of said inlet passage.
22. Apparatus as claimed in Claim 19, 20 or 21 in which said profile forming dies are the same.
23. Apparatus as claimed in Claim 19, 20 or 21 in which said profile forming dies are different.
24. Apparatus as claimed in Claim 19 or 20 having slidable means for opening and closing flow through one of said diverging output passages.

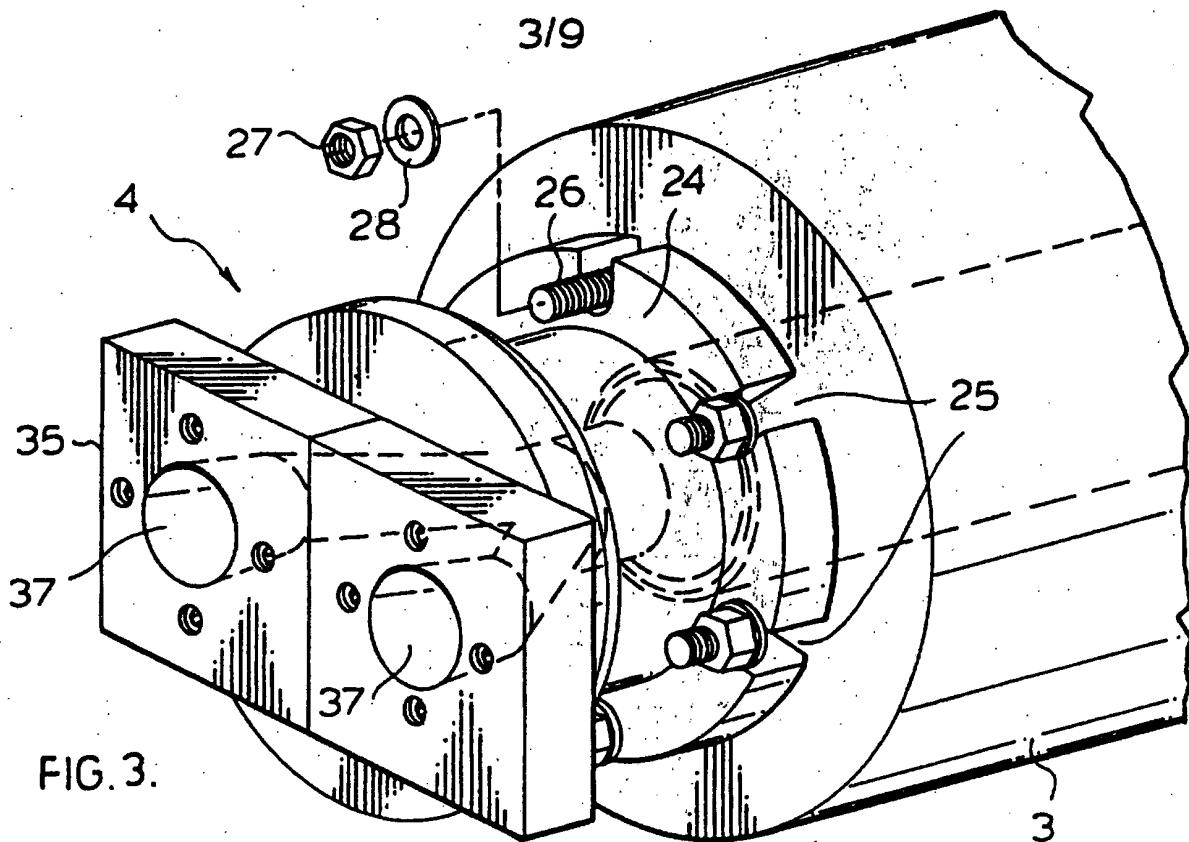


FIG. 3.

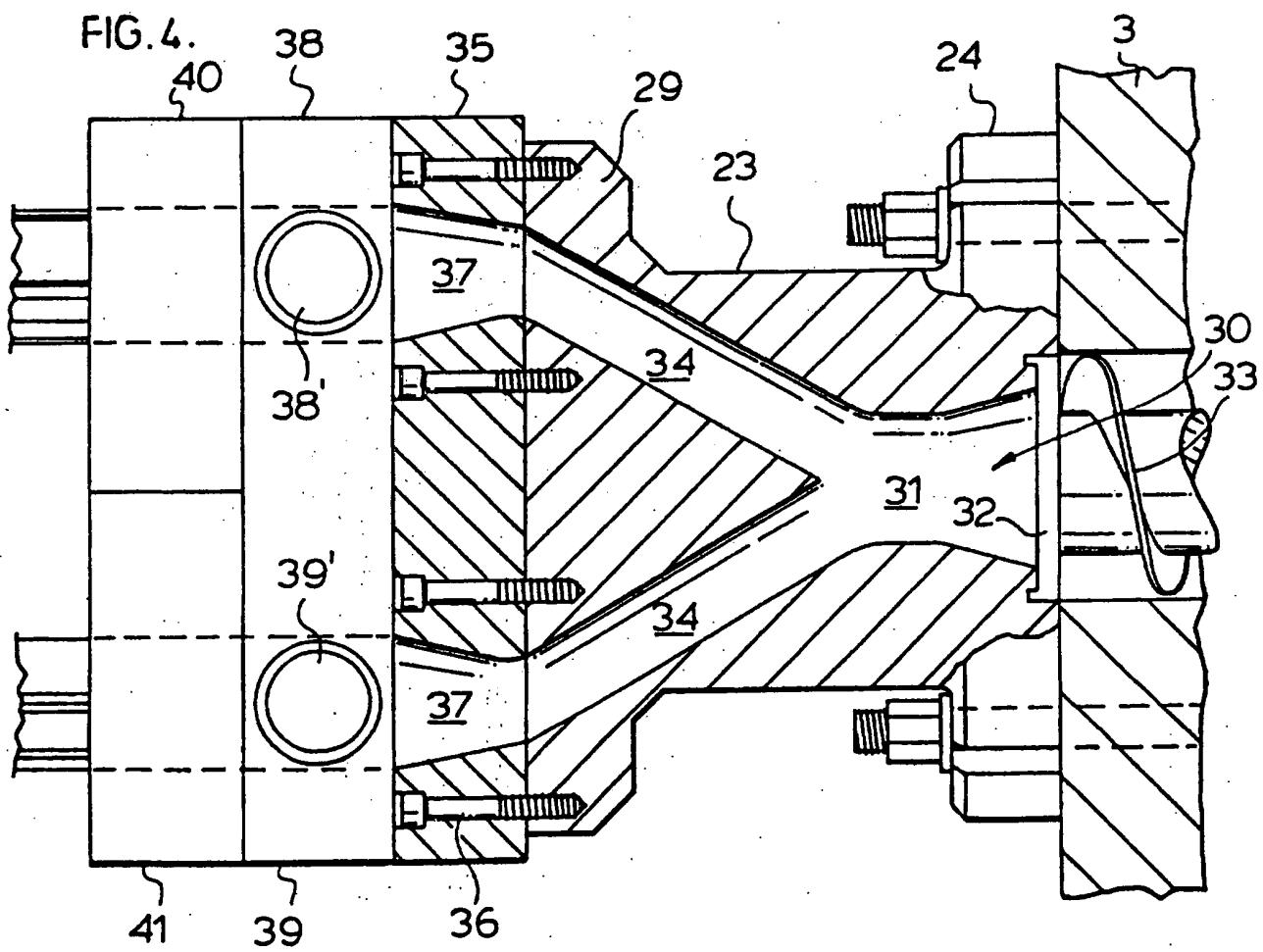


FIG. 4.

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FIG.5.

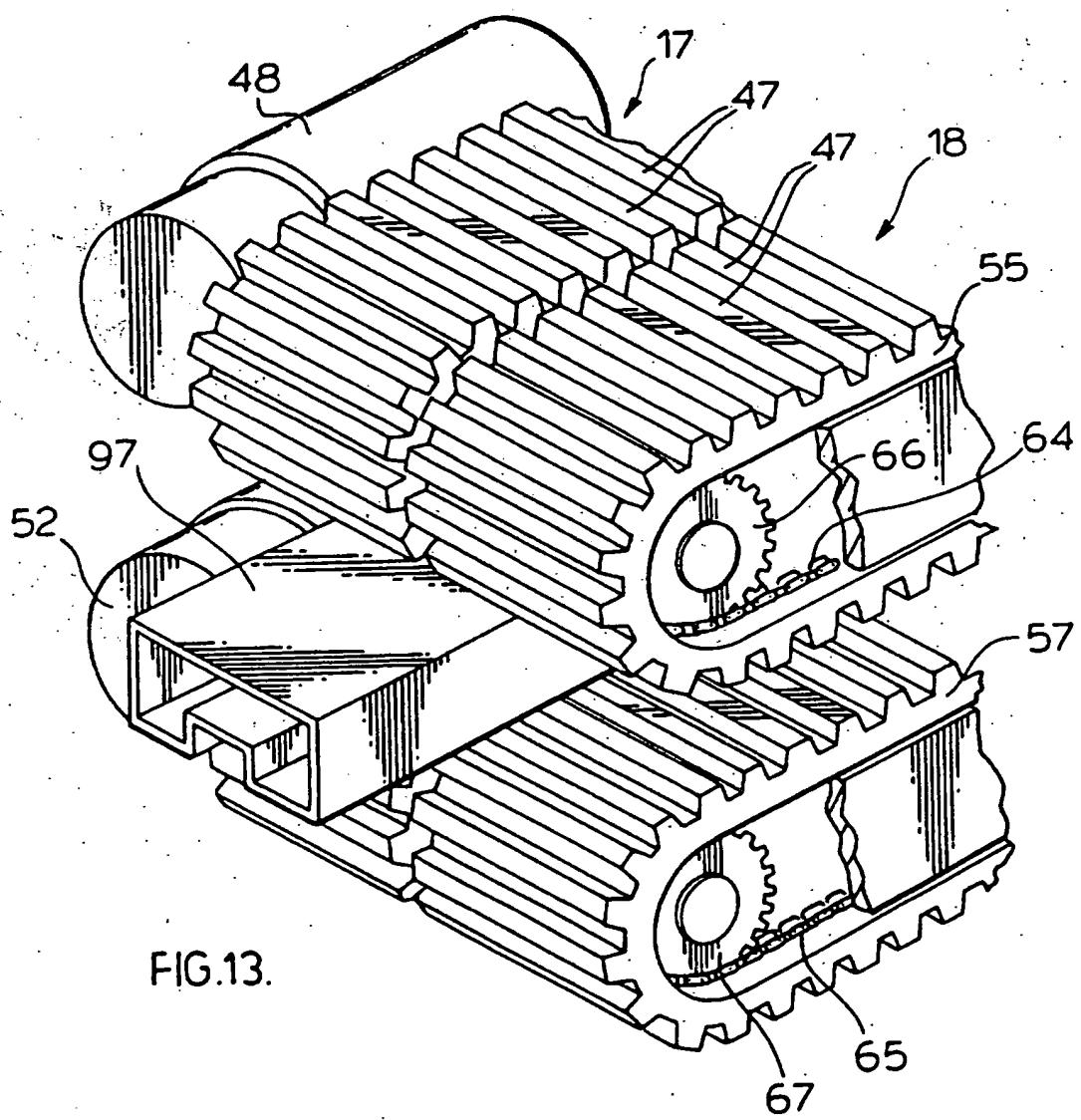
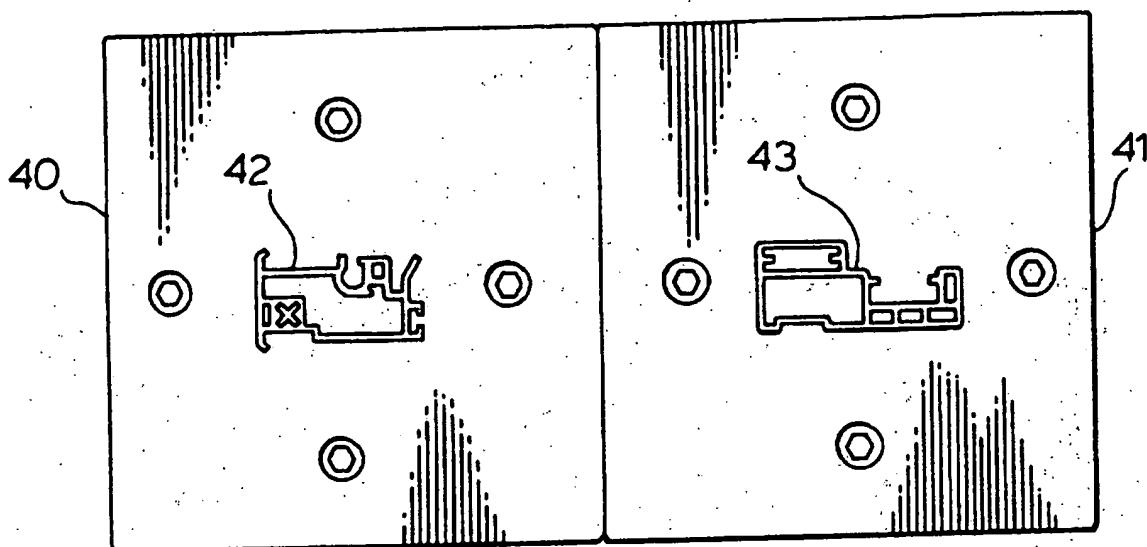


FIG.13.

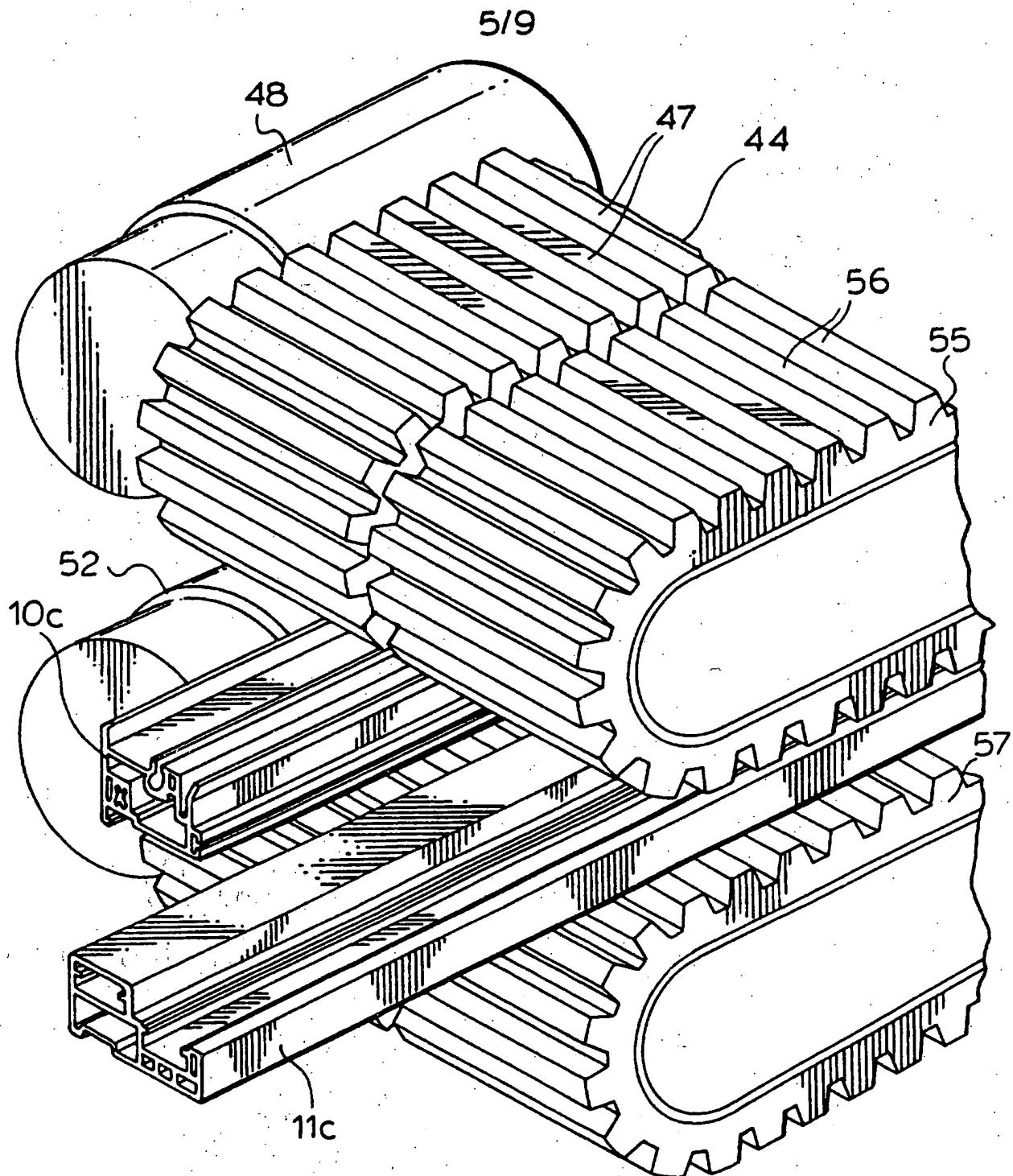
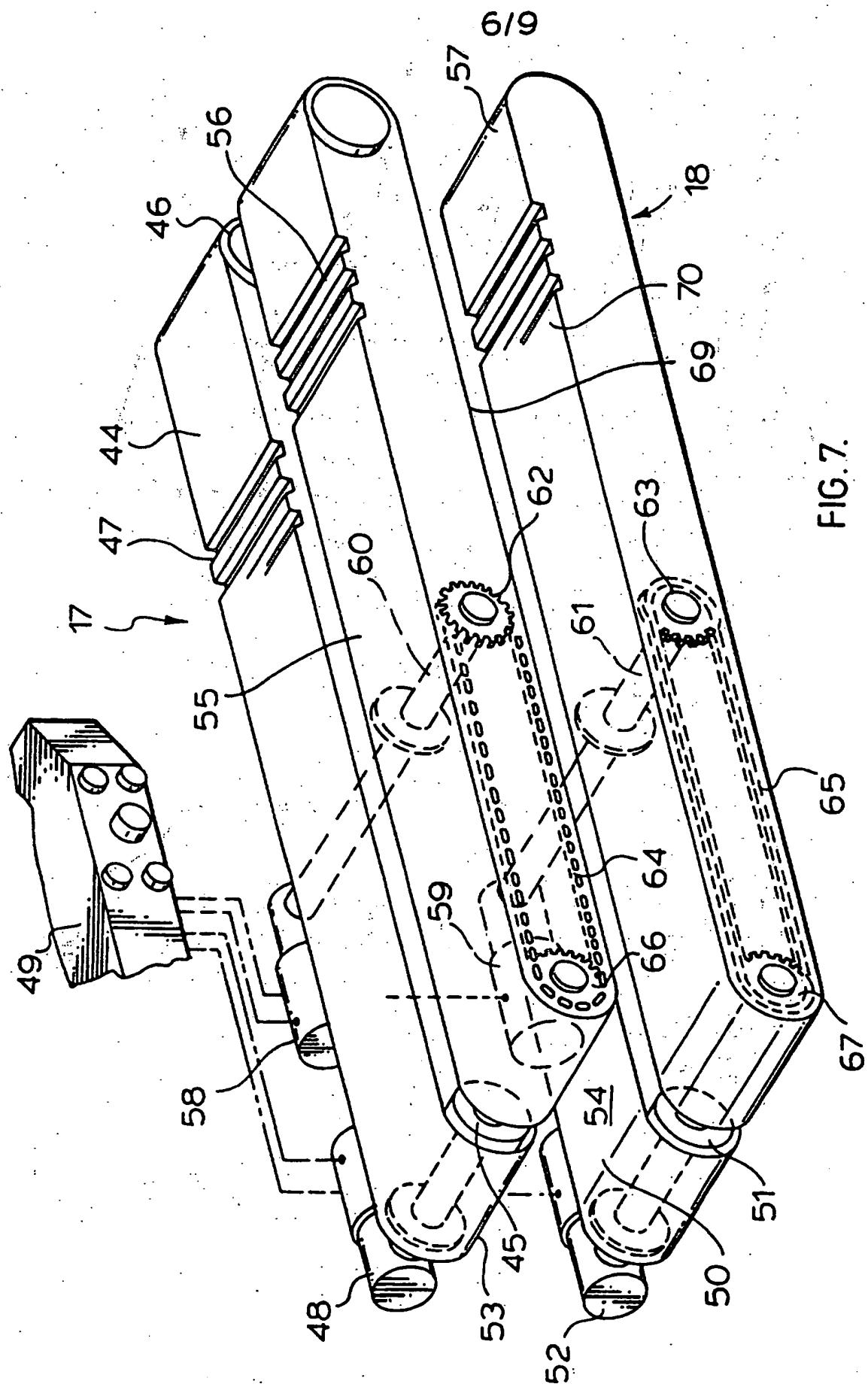
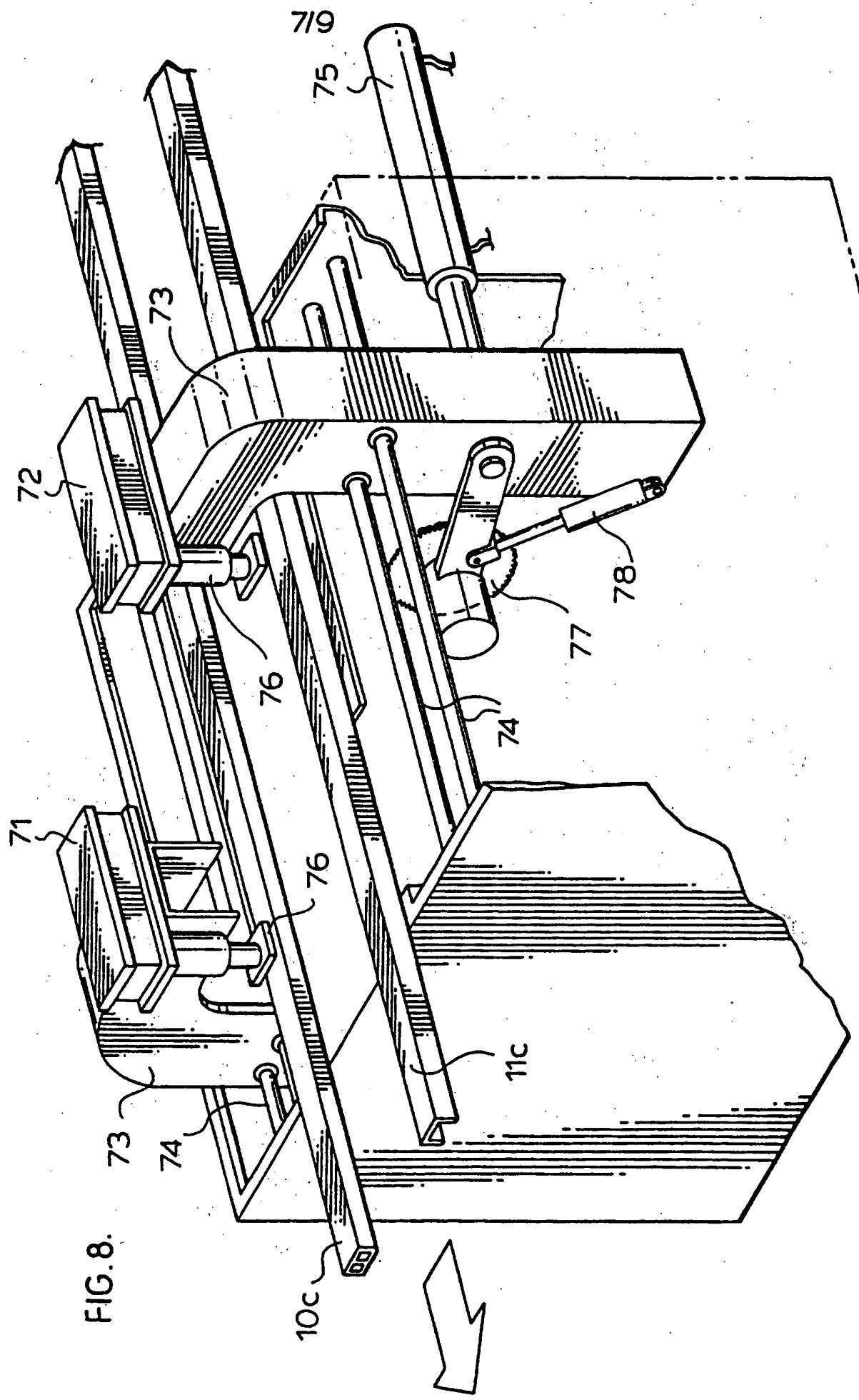


FIG. 6.





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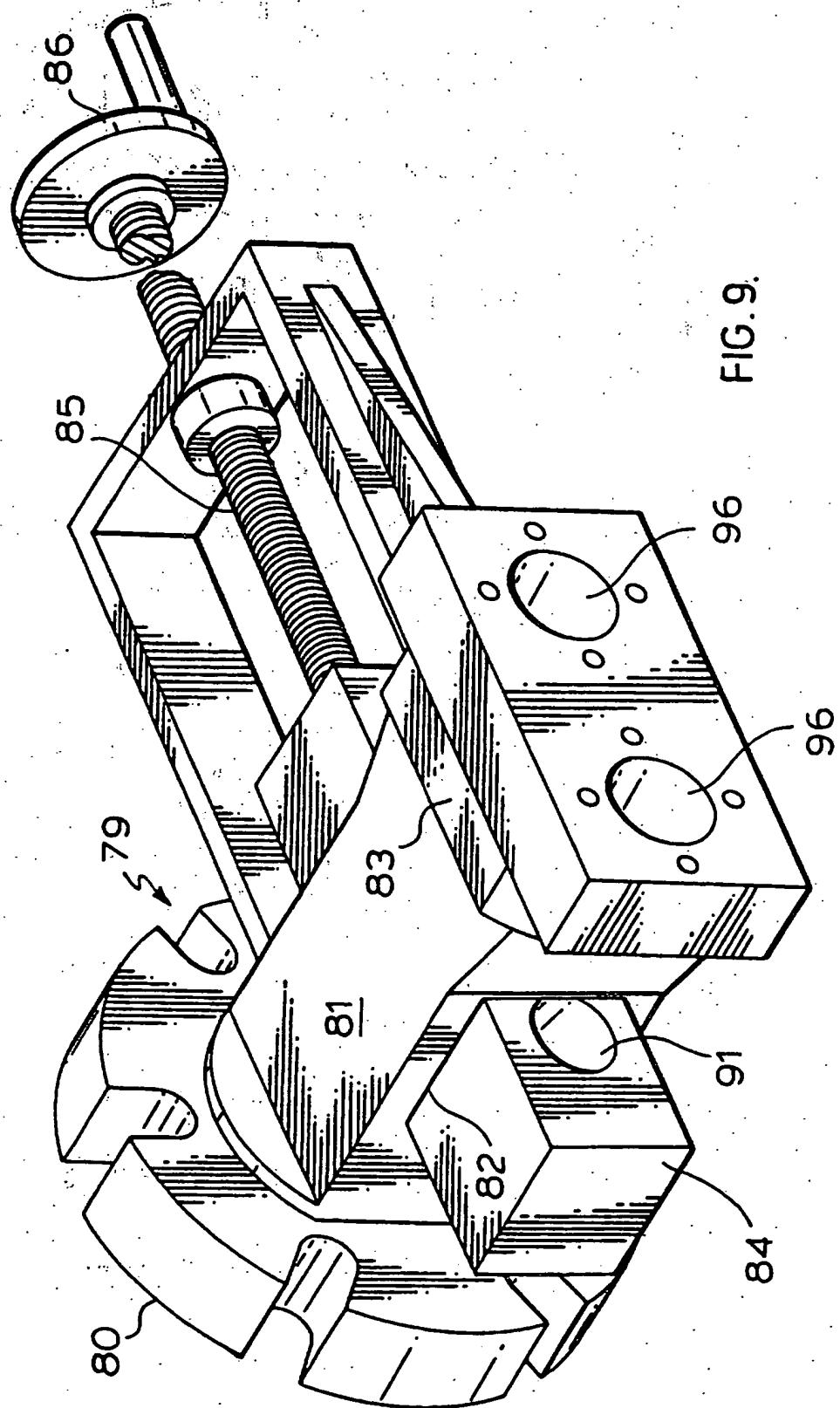


FIG.11.

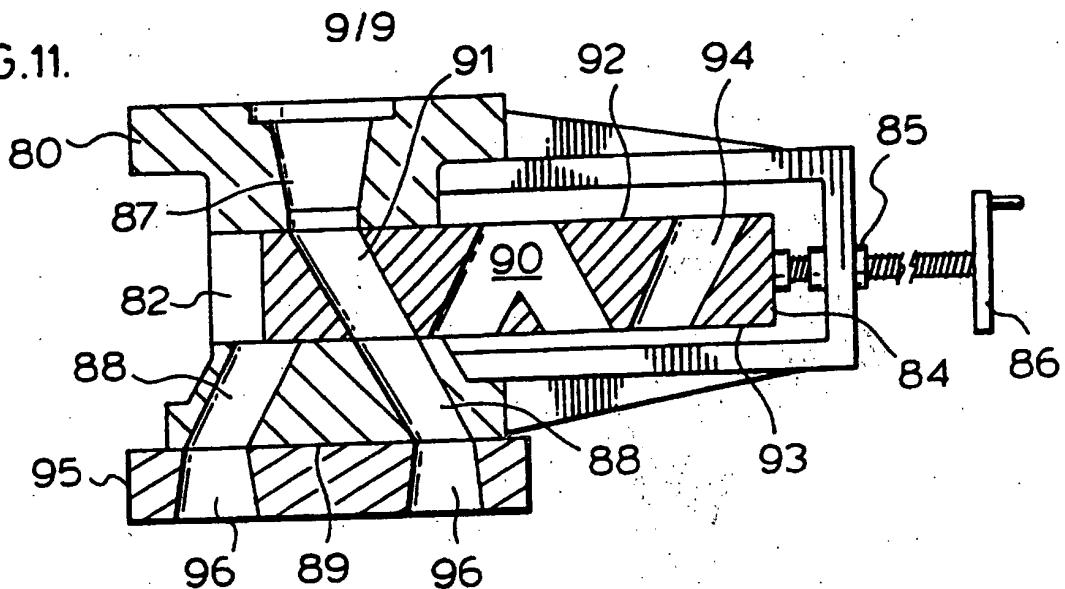


FIG.10.

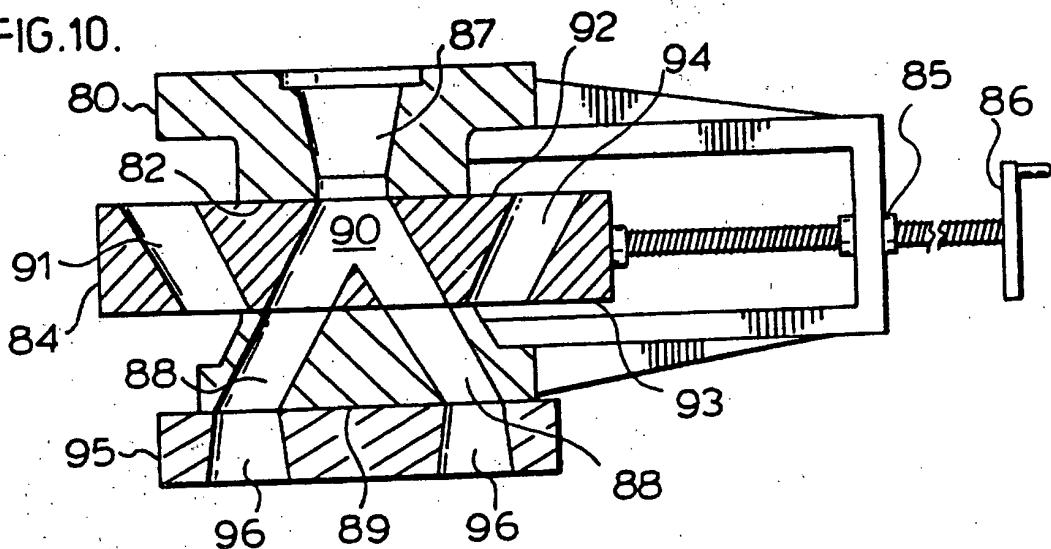
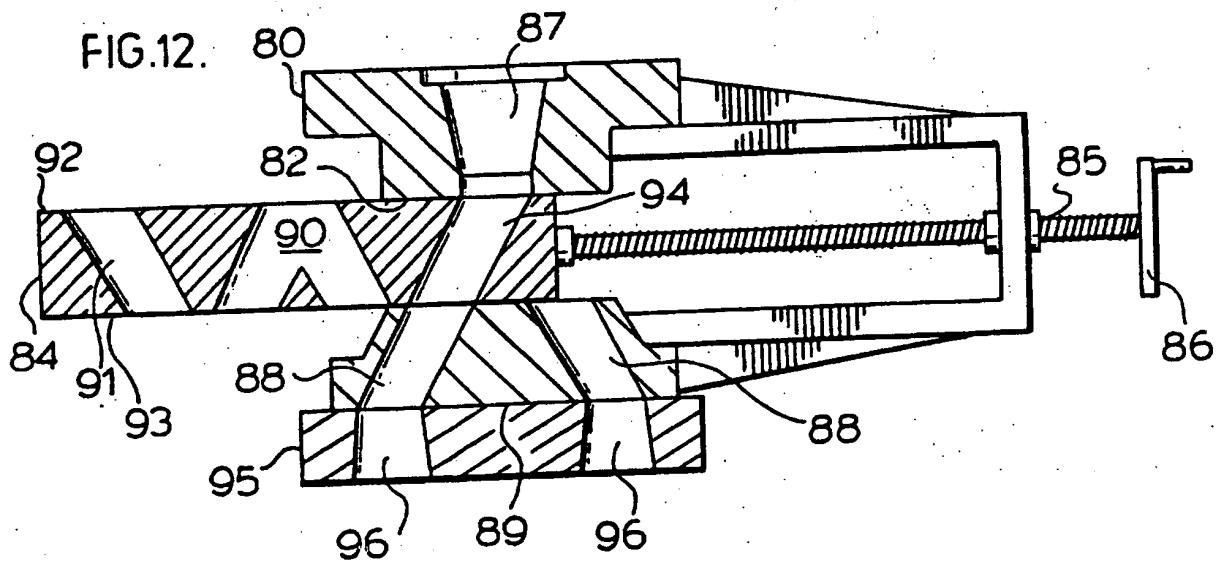


FIG.12.

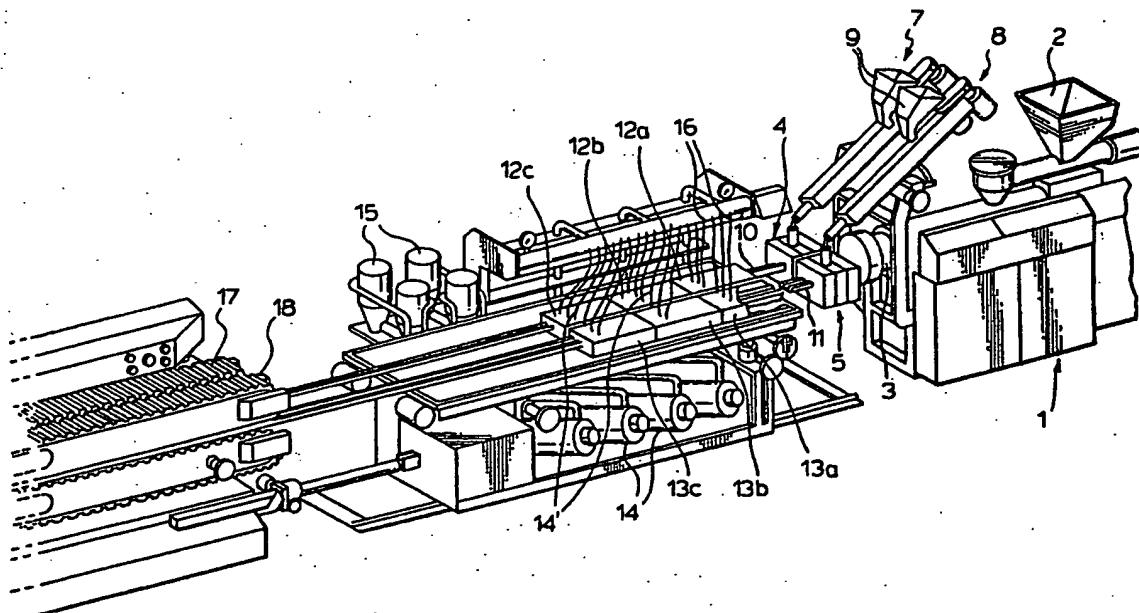




## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification <sup>6</sup> :		A3	(11) International Publication Number: <b>WO 96/29186</b>
<b>B29C 47/70, 47/34</b>			(43) International Publication Date: 26 September 1996 (26.09.96)
(21) International Application Number: PCT/CA96/00156		(81) Designated States: AU, CN, JP, MX, NO, NZ, US, European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).	
(22) International Filing Date: 14 March 1996 (14.03.96)			
(30) Priority Data: 2,144,719 15 March 1995 (15.03.95) CA		Published With international search report. Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.	
(71) Applicant (for all designated States except US): ROYAL PLASTICS GROUP LIMITED [CA/CA]; 1 Royal Gate Boulevard, Woodbridge, Ontario L4L 8Z7 (CA).		(88) Date of publication of the international search report: 28 November 1996 (28.11.96)	
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## (54) Title: EXTRUSION METHOD AND APPARATUS THEREFOR



## (57) Abstract

A method of simultaneously extruding at least two thermoplastic profiles (10, 11) utilizing a single extruder (1) outputting a flow of heated thermoplastic material comprising dividing the output flow from the extruder (1) into at least two streams, delivering each of said streams through a profile forming die to convert the stream to a profiled stream, individually pulling (17, 18) each profiled stream (10, 11) emerging from its profile forming die through a calibrating unit for that profile, and adjusting the speed of pull of each profiled stream so that the take away of the profiled stream from its respective profile forming die matches the rate at which it emerges therefrom. The invention also includes apparatus for carrying out the method.

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## INTERNATIONAL SEARCH REPORT

Int. Application No  
PCT/CA 96/00156

## A. CLASSIFICATION OF SUBJECT MATTER

IPC 6 B29C47/70 B29C47/34

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 6 B29C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	MODERN PLASTICS, vol. 18, no. 12, December 1988, LAUSANNE CH, pages 49-53, XP000023575 GEORGE R. SMOLUK: "Downstream hardware keeps up with pipe, tubing and profile extrusion" see page 49, left-hand column, line 1 - line 14 see page 49, left-hand column, line 33 - right-hand column, line 13 see page 50, middle column, line 24 - line 28	1-14, 16-18
Y	---	19-26 -/-

 Further documents are listed in the continuation of box C. Patent family members are listed in annex.

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1 Date of the actual completion of the international search

3 October 1996

Date of mailing of the international search report

16. 10. 96

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## INTERNATIONAL SEARCH REPORT

International Application No  
PCT/CA 96/00156

## C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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X	GB,A,2 060 474 (BELL AG MASCHF) 7 May 1981 see figures 1,2 see page 1, line 74 - line 83	27,29
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A	---	1-23
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A	---	1-3,6-8, 11-15, 19-22,24
Y	DE,A,35 14 421 (CONTINENTAL GUMMI WERKE AG) 23 October 1986 see figures 1-3	25,26
A	BE,A,703 752 (SOLVAY ET CIE) 12 March 1968  see figure 1	1-14, 19-23, 27,29
A	US,A,5 238 165 (GROEBLACHER HANS ET AL) 24 August 1993 see column 4, line 20 - line 24 see figure 6	16-18
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Information on patent family members

International Application No  
PCT/CA 96/00156

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